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Ether as an electro-gravimagnetic field, its density and properties

Abstract. Based on biquaternion wave (*biwave*) equations, a biquaternionic model of the ether is developed – an electro-gravimagnetic field, the state of which is described by the biquaternion of the strength of EGM field. Its complex scalar part determines the density of the ether, and the complex vector part characterizes the strength of the electric and gravimagnetic fields. The biquaternion gradient of the ether biquaternion determines the biquaternion of EGM charge-current, which contains in the scalar part the electric charge and gravitational mass, and the vector part is formed by electric and gravimagnetic currents. Special cases of these biwave equations are the biquaternionic representation of the Maxwell and Dirac equations.

Representations of biquaternion of photons and elementary atoms are obtained as partial stationary solutions of biwave equations with a fixed oscillation frequency. The presence of a gravitational component of the EGM field of the photon is shown, which explains the light pressure. Using the biquaternion model of the atom, a periodic system of atoms is constructed based on the structure of a simple musical scale.

A field analogue of Newton's second law is presented as a biquaternion generalization of the Dirac system of equations. It describes the transformation of the EGM charge-current biquaternion under the influence of an external EGM field. It contains, in addition to all known physical forces, a number of new forces that are proposed for discussion and experimental verification.

The biquaternion representation of Newton's third law of action and reaction in the scalar part is a well-known analogue of Betti's law on the power of forces acting on EGM charges and currents.

Key words: biquaternion wave, electro-gravimagnetic field, Betti's law, complex vector, bigradients.

Introduction

Modern Newtonian mechanics is based on the three basic laws formulated by Newton for a material point. Based on these laws, the equations of motion of systems of material points, a rigid body, and mechanics of continuous media were constructed. However, real material bodies are not material points, but consist of distributed masses, characterized by gravitational density, electric charge, which move (the state of rest is always only relative). Is it possible to construct equations of state for a continuous medium without initially using the material point model, which requires discretization of a continuous medium to construct its equations of motion?

The Poisson equation is indicative here, the solutions of which describe the potentials of the gravitational or electric fields, if the densities of masses or electric charges are on the right side of the equation, respectively. Moreover, if they are moving? For moving electric charges and currents, the emerging electromagnetic fields describe Maxwell equations. In addition, what will be the gravitational fields of the moving masses – the question remains open to this day.

However, these questions have a positive answer, if we use a more complex mathematical apparatus to describe the motion of material media, which is the differential algebra of biquaternions [1-2]. Here, based on this algebra, the equations of motion of distributed masses and electric charges and the gravitational and electromagnetic fields generated by them are proposed. Equations for the interaction of charges and currents and energy relations characterizing the interaction energy are constructed.

By this the model is based on the same Newton laws of inertia, proportionality of force and acceleration, action and counter-action, only formulated in terms of biquaternion gradients (*bigradients*), generalizing the concept of a gradient to scalar-vector fields. The constructed equations are biquaternionic generalization of Maxwell equations (GME) and Dirac equations (GDE). The static GME solutions describe static gravitational and electric fields, the potentials of which satisfy the Poisson equation.

Those the proposed model includes the well-known classical equations of mathematical physics and field theory, which combines the gravitational field and the electromagnetic field into a single electro-gravimagnetic field. At the same time, biquaternionic field analogue of Newton second law, in addition to the known physical forces, contains new forces that are offered to the audience for discussion.

1. Biquaternions and bigradients

The foundations of differential algebra of biquaternions are presented by the author in [1-2]. Here we briefly give the basic concepts necessary to describe the biquaternionic model of EGM field. We introduce a complex space of quaternions $\mathrm{K} = \{\mathbf{F} = f + F\}$ (f are complex numbers: $f = f_1 + if_2$, and F is a three-dimensional vector with complex components: $F = F_1 + iF_2$). K is a linear space with the well-known operation of quaternionic multiplication ($\circ$):

$$\begin{gathered}\mathbf{F}\circ\mathbf{G} = (f+F)\circ(g+G) = \\ = (fg - (F,G)) + (fG + gF + [F,G])\end{gathered} \quad (1)$$

which is noncommutative, but associative: $(\mathbf{F}\circ\mathbf{G})\circ\mathbf{H} = \mathbf{F}\circ(\mathbf{G}\circ\mathbf{H})$. Further, we use *mutual bigradients*. These are differential operators of the form

$$\begin{gathered}\nabla^{\pm}\mathbf{F} = (\partial_\tau \pm i\nabla)\circ(f+F) = \\ (\partial_\tau f \mp i\, divF) \pm \partial_\tau F \pm i\mathrm{grad}\, f \pm i\mathrm{rot}\, F\end{gathered} \quad (2)$$

Their composition gives the wave operator:

$$\nabla^{-}\left(\nabla^{+}\mathbf{K}\right) = \nabla^{+}\left(\nabla^{-}\mathbf{K}\right) = \frac{\partial^2\mathbf{K}}{\partial\tau^2} - \Delta\mathbf{K} \triangleq \Box\mathbf{K}\,. \quad (3)$$

It is convenient to use this property when solving biquaternionic wave (*biwave*) equations:

$$\nabla^{\pm}\mathbf{B} = \mathbf{G}(\tau,x) \quad (4)$$

An example of such an equation is the system of Maxwell equations, which is reduced to the biwave equation (4) (with the sign +).

2. Biquaternions of the electro-gravimagnetic field. Either equation

Let consider in the Minkowski space $(\tau,x) = \{\tau = ct, x_1, x_2, x_3\}$ the EGM-field generated by distributed electric charges and masses and their currents. To describe it, the following biquaternions (*Bq*) is introduced:

either Bq
$$\begin{gathered}\mathbf{A}(\tau,x) = i\alpha + A, \quad \alpha = \alpha_1 + i\alpha_2, \\ A = E + iH\end{gathered} \quad (5)$$

where a scalar part $\alpha(\tau,x)$ is named *either density*, E and H are tensions of electric and *gravimagnetic* fields (a potential part H corresponds to a strength of gravitational field, and its vortex component corresponds to a strength of magnetic field B:

$$H = G + B, \ rot\ G = 0, \ div\ B = 0. \quad (6)$$

Also we determine

charge-current Bq
$$\mathbf{\Theta}(\tau,x) = i\rho + J\,, \quad \begin{gathered}\rho = -\rho^E + i\rho^H, \\ J = -J^E + iJ^H\end{gathered} \quad (7)$$

Here $\rho^E(\tau,x)$ and $\rho^H(\tau,x)$ are densities of electric charge and gravitational mass, $J^E(\tau,x)$, $J^H(\tau,x)$ are the density of electric and gravimagnetic currents.

It has the form of the biwave equation –

either equation $\nabla^{+}\mathbf{A} = \mathbf{\Theta}(\tau,x) \quad \Leftrightarrow \quad (8)$

$$\partial_\tau\alpha - div\ A = \rho, \quad \partial_\tau A + i\,\mathrm{rot}\,A = J \quad \Leftrightarrow \quad (9)$$

$$\begin{cases} \operatorname{rot} H = \partial_\tau E + J^E, & \operatorname{rot} E = -\partial_\tau H + J^H \\ \rho^E = \partial_\tau \alpha_2 + div\ E, & \rho^H = \partial_\tau \alpha_1 - div\ H \end{cases} \quad (10)$$

When

$$\alpha = 0,\ div\, H = 0,\ J^H = 0, \quad (11)$$

the Eqs (10) coincide with Maxwell equations. From (8) it follows that the charges-currents are *physical manifestation of bigradient of EGM-field.*

Energy density and Poynting vector of EM field are generalized into the *energy-momentum* biquaternion of EGM field

$$\mathbf{\Xi} = \frac{1}{2}\mathbf{A}^* \circ \mathbf{A} = W_{\mathbf{A}} + iP_{\mathbf{A}}, \quad \mathbf{A}^* = -i\bar{\alpha} - \bar{A},$$
$$W_{\mathbf{A}} = 0,5\left(|\alpha|^2 + \|A\|^2\right), \quad (12)$$
$$P_{\mathbf{A}} = -\operatorname{Re}(\alpha\bar{A}) + [\operatorname{Re}(A), \operatorname{Im}(A)]$$

Here $W_{\mathbf{A}}$ is energy density, $P_{\mathbf{A}}$ is the Poynting vector, which characterizes the direction of energy propagation in the EGM medium. Both of these values are valid.

The mutual bigradient from Eq (8) gives the wave equation for EGM tension:

$$\Box \mathbf{A} = \nabla^- \mathbf{\Theta}(\tau, x) J \quad \Rightarrow$$
$$\Box \alpha = \partial_\tau \rho + div\, J, \quad (13)$$
$$\Box A = \nabla \rho + \partial_\tau J - i rot J$$

Whence it follows that electric, magnetic and gravitational waves propagate at the light speed.

The biquaternion of the energy-momentum of EGM charges-currents is

$$\mathbf{\Xi}_{\mathbf{\Theta}} = 0,5\mathbf{\Theta} \circ \mathbf{\Theta}^* = -\left(i\rho + J\right) \circ \left(i\bar{\rho} + \bar{J}\right) =$$
$$= 0,5\left(|\rho|^2 + \|J\|^2\right) - \quad (14)$$
$$-i\left\{\operatorname{Re}\left(\rho\bar{J}\right) - i\left[\operatorname{Re} J, \operatorname{Im} J\right]\right\} = W_{\Theta} + iP_{\Theta}$$

Here W_{Θ} characterizes the energy density of EGM charges-currents, and Poynting vector P_{Θ} de termines the direction of propagation of this energy.

EXAMPLE 1. Let consider photons as some solutions of A-field Eq (8).

Definition. We call a photon an *elementary,* generated by a concentrated EGM charge of the form: $\mathbf{\Theta}(\mathbf{x}, \tau) = i\delta(\mathbf{x})\ e^{-i\omega\tau}$.

Its has the biquaternionic representation

$$\mathbf{\Phi}^0(\mathbf{x}, \tau) = \frac{e^{i\omega(r-\tau)}}{4\pi r}\left\{\omega + \mathbf{e}_{\mathbf{x}}\left(i\omega + \frac{1}{r}\right)\right\},$$
$$\mathbf{e}_{\mathbf{x}} = \mathbf{x}/r, \quad r = \|\mathbf{x}\|.$$

Its energy-momentum

$$\mathbf{\Xi}^0_{\Phi}(\mathbf{x}, \omega) = \frac{1}{\pi r^2}\left\{\omega^2 + \frac{1}{2r^2} + i\omega^2 \mathbf{e}_{\mathbf{x}}\right\}.$$

Note that scalar part $\mathbf{\Phi}^0(\mathbf{x}, \tau)$ is equal to

$$\frac{\omega}{4\pi r}e^{i\omega(r-\tau)} =$$
$$= \frac{\omega}{4\pi r}\left(\cos\omega\left(r - \tau\right) + i\sin\omega\left(r - \tau\right)\right)$$

Here the real part determines the density of the electric field of the photon, the imaginary part is the density of the gravimagnetic field of the photon. And the imaginary part $\mathbf{\Phi}^0(\mathbf{x}, \tau)$ is a gravimagnetic wave that generates light pressure.

For the construction of biquaternions of photons and light, see [13, 14].

3. Third Newton law of charge-current interaction

Let's consider two EGM-fields $\mathbf{A}$ and $\mathbf{A}'$, generated by charges-currents $\mathbf{\Theta}, \mathbf{\Theta}'$. We introduced a biquaternion of power – density of the forces acting from the field $\mathbf{A}'$ on the charges-currents $\mathbf{\Theta}(\tau, x)$ of the field $\mathbf{A}$ in form

$$\mathbf{F} = f + iF = \mathbf{A}' \circ \mathbf{\Theta} =$$
$$= -(\rho\alpha' + (A', J)) + i\left\{\alpha' J + \rho A' - i[A', J]\right\} \quad (15)$$

Its scalar part has the form of a power of acting forces:

$$f=-(A',J)-\rho\alpha'=(E',J^{E})+(H',J^{H})+ \\ +i(H',J^{E})-i(E',J^{H})-\rho\alpha'\triangleq M \quad (16)$$

and the vector part contains all known forces and not only

$$F=\alpha' J+\rho A'-i[A',J] \quad \Rightarrow$$

$$\mathrm{Re}(F)=-\rho^{E}E'-\rho^{H}H'+[E',J^{H}]- \\ -[H',J^{E}]+\mathrm{Re}(\alpha' J)=-\rho^{E}E'-\rho^{H}G'+[J^{E},B']- \\ -\left\{\rho^{H}B'+[G',J^{E}]-[E',J^{H}]+\mathrm{Re}(\alpha' J)\right\} \quad (17)$$

$$\mathrm{Im}(F)= \\ =\left\{\rho^{H}E'-\rho^{E}H'+[E',J^{E}]+[H',J^{H}]+\mathrm{Im}(\alpha' J)\right\}$$

Indeed, in $\mathrm{Re}(F)$ on the right there are known forces: the Coulomb force of electric action $\rho^{E}E'$, in vortex part of the vector H' there is the Lorentz force $B'\times J^{E}$, in the potential part of the vector H' there is a gravitational force $\rho^{H}G'$.

Also you see here on the right the unknown forces (in curly brackets) : *electromass* force $E'\times J^{H}$ of electric field impact on mass currents; *gravimagnetic* force $\rho^{H}B'$ of influence of magnetic field on mass; *gravielectric* force $[G',J^{E}]$ of gravity action on electric currents. These forces, $\alpha' J$ and ones in $\mathrm{Im}(F)$ are *the new forces.*

Similarly, we introduce the power-force biquaternion of acting from the A-field on the charges-currents of the A'-field:

$$\mathbf{F}'=f'+iF'=\mathbf{A}\circ\mathbf{\Theta}'.$$

According to third Newton law on action and counteraction we postulate

The law for EGM action-contraction:

$$\mathbf{F}'=-\mathbf{F} \Leftrightarrow \mathbf{A}'\circ\mathbf{\Theta}=-\mathbf{A}\circ\mathbf{\Theta}' \quad (18)$$

We name Eq (16) as *third Newton law for EGM charges-currents*.

4. Newton's second law and interaction equations.

By analogue of second Newton law we postulate

The law for EGM charges-currents interaction

$$\kappa\ \nabla^{-}\circ\mathbf{\Theta}=\mathbf{F},\quad \kappa\ \nabla^{-}\circ\mathbf{\Theta}'=\mathbf{A}\circ\mathbf{\Theta}' \quad (19)$$

Here the interaction constant κ is like to gravitational constants. Together with biwave equations for EGM fields:

$$\nabla^{+}\circ\mathbf{A}=\mathbf{\Theta},\quad \nabla^{+}\circ\mathbf{A}'=\mathbf{\Theta}', \quad (20)$$

and the third Newton law (16), they give a closed system of nonlinear differential equations for $\{\mathbf{\Theta},\mathbf{A}\},\{\mathbf{\Theta}',\mathbf{A}'\}$ determination.

The introduction of a constant κ is related to dimension. The dimension $\mathbf{A}$ is denoted by $[\mathbf{A}]=\alpha$ (energy density), $[x]=l$ (length), then $[\mathbf{\Theta}]=\alpha l^{-1}$, $[\kappa]=\alpha l$. Let's call κ the *radiation constant*, because its dimension determines the density of the energy flux through the surface.

Expanding the scalar and vector parts of (18), we obtain

EGM field charge-current transformation equations

$$i\kappa\ \left(\partial_{\tau}\rho+divJ\right)=-(A',J)-\rho\alpha'=M \quad (21)$$

$$\kappa\left(\partial_{\tau}J-irotJ+\nabla\rho\right)= \\ =iF=i\alpha' J+i\rho A'+[A',J] \quad (22)$$

под воздействием внешнего ЭГМ-поля $\mathbf{A}'$.

It follows from (19) that charge conservation law changes when the charges-currents interact under the influence of the *EGM* fields generated by them. A nonzero right-hand side appears in the equation, associated with the power M of the forces of action from another field, which is naturally observed in open systems. From scalar part of (20) we obtain

The law of conservation of electric charge and gravitational mass:

$$\kappa\ \left(\partial_\tau \rho^E + div\, J^E\right) =$$
$$= -(H', J^E) - (E', j^H) - \mathrm{Im}(\rho\alpha') \qquad (23)$$
$$\kappa\ \left(\partial_\tau \rho^H + div\, J^H\right) =$$
$$= -(H', j^H) + (E', J^E) + \mathrm{Re}(\rho\alpha')$$

As you can see, the power of the electric and gravimagnetic forces of the second field affects the mass and mass currents of the first.

The imaginary part of the vector equation (20) gives the equations of motion of gravimagnetic currents:

Field analogue of Newton's second law

$$\kappa\left(\partial_\tau J^H - rotJ^E + \nabla\rho^H\right) =$$
$$= \rho^E E' - \rho^H H' + [E', J^H] + \qquad (24)$$
$$+ [H', J^E] + \mathrm{Re}\left(\alpha' J\right)$$

where the analogue of momentum is the density of gravimagnetic currents J^H. The real part of Eq (20) gives

Equations of motion of electric currents

$$\kappa\left(\partial_\tau J^E + irotJ^H + \nabla\rho^E\right) =$$
$$= -\rho^H E' - \rho^E H' + [E', J^E] - \qquad (25)$$
$$-[H', J^H] - \mathrm{Im}\left(\alpha' J\right)$$

It describes the effect of an external field on electric currents. Its analog in modern physics is unknown to the author.

If the external EGM field is much more powerful than the intrinsic field of charge-currents, then its change can be ignored. Then we have a linear system of biquaternionic equations for determining the transformation of masses, charges and their currents under its influence, which we name the

Charge-currents transformation equation

$$\nabla^- \circ \mathbf{\Theta} = \kappa^{-1}\ \mathbf{A}' \circ \mathbf{\Theta} \qquad (26)$$

where the biquaternion $\mathbf{A'}$ of the external EGM field is known.

From (26) by use (8) and (18) we get

$$\Box\mathbf{A} - \kappa^{-1}\ \mathbf{A} \circ \mathbf{\Theta'} = \mathbf{0}, \qquad (27)$$

$$\Box\mathbf{\Theta} + \kappa^{-1}\ \nabla^+\left(\mathbf{A'} \circ \mathbf{\Theta}\right) = \mathbf{0}, \qquad (28)$$

Eqs (26) and (27) are the biquaterninic generalization of Dirac and Klein-Gordon equations.

6. The first Newton law for EGM field. The law of inertia

For free charge-currents $\mathbf{F} = 0$. Hence, from second Newton law for EGM of charge-currents, we obtain

The law of inertia

$$\nabla^- \mathbf{\Theta} = 0 \quad \leftrightarrow \qquad (29)$$

$$\partial_\tau \rho + div\ \ J = 0,\ grad\,\rho + \partial_\tau J - irotJ = 0 \quad (30)$$

The first scalar equation is the mass-charge conservation law, which naturally must be satisfied in closed systems. The second vector equation defines the free motion (*inertia*) of electric and gravimagnetic currents in the absence of external influences, which is completely due to the inhomogeneity of the state associated with the presence of gradients and rotors of these fields. Separating the real and imaginary parts from (29) we get

First Newton law for mass charges and EGM field curents:

$$\begin{gathered} \partial_\tau J^E - rot\ \ J^H + grad\ \ \rho^E = 0, \\ \partial_\tau \rho^E + div\ \ J^E = 0; \\ \partial_\tau J^H + rot\ \ J^E + grad\ \ \rho^H = 0, \\ \partial_\tau \rho^H + div\ \ J^H = 0 \end{gathered} \qquad (31)$$

These equations give a closed system of equations for determining the charges and currents of the A-field in the absence of external fields.

Solutions of equation (27) can be used for biquaternionic representations of elementary particles. In particular, the author used monochromatic solutions of equation (27) to construct harmonic bosons and leptons [11].

EXAMPLE 2. By use harmonic bosons, a periodic system of elementary atoms has been presented, constructed on the principle of a simple musical scale [12]:

Simple gamut							
do	*re*	*mi*	*fa*	*sol*	*la*	*si*	*do*
ω	9ω/8	5ω/4	4ω/3	3 ω /2	5 ω /3	15 ω /8	2ω

Periodic table of elementary atoms						
1	2	3	4	5	6	7
$\omega_1 = \omega$	9ω/8	5ω/4	4ω/3	3 ω /2	5 ω /3	15 ω /8
$\omega_2 = 2\omega_1$	$9\,\omega_2/8$	$5\,\omega_2/4$	$4\,\omega_2/3$	$3\,\omega_2/2$	$5\,\omega_2/3$	$15\,\omega_2/8$
$\omega_3 = 2\omega_2$	$9\,\omega_3/8$	$5\,\omega_3/4$	$4\,\omega_3/3$	$3\,\omega_3/2$	$5\,\omega_3/3$	$15\,\omega_3/8$
…	…	…	…	…	…	…
$\omega_n = 2\omega_{n-1}$	$9\,\omega_n/8$	$5\,\omega_n/4$	$4\,\omega_n/3$	$3\,\omega_n/2$	$5\,\omega_n/3$	$15\,\omega_n/8$
…	…	…	…	…	…	…

The elementary atom in this periodic system has the form:

$$\mathbf{At}^{n,k}(t,x) = \frac{1}{r} e^{-iw_{n,k}t/c} \left\{ \sin\left(w_{nk}r/c\right) + \left(\cos\left(w_{nk}r/c\right) - c\frac{\sin\left(w_{nk}r/c\right)}{w_{nk}r} \right) e_{\mathbf{x}} \right\}.$$

where the oscillation frequency $w_{nk} = 2^{n-1}\gamma_k w_{H_0}$ of the element in k-column of n-row of the periodic table , γ_k is the multiplier in k-column, w_{H_0} is the oscillation frequency of elementary hydrogen atom $\mathbf{At}^{1,1}(H_0)$.

Conclusion

We introduced postulates for EGM-field on the base of generalization of biquaternionic form of

Maxwell and Dirac equations and obtained closed hyperbolic system which connect EGM-field, charges and currents in united system of equations. For this we enter new scalar α -field which is the either density. It characterizes an attraction-resistance properties of the either. That gives possibility to explain some physical phenomena which are observed in practice. In particular, the solutions of EGM-field describe electric and gravimagnetic waves which, in general case, are not transversal and have longitudinal component. Longitudinal EM-waves are observed in practice but classic electrodynamics doesn't explain there existence. Many interesting physical properties of this model appear by interaction of different system of charges and currents and their EGM-fields. Some of them were described in papers [1-3].

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